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The Patent Office

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P01/7700 0.00 - 9823669.8

Request for grant of a patent

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The Patent Office

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Newport
Gwent NP9 1RH

1. Your reference P22833/HGR/GMU

2. Patent application number
(The Patent Office will fill in this part) **9823669.8**

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Serck Heat Transfer Limited
Warwick Road
BIRMINGHAM
B11 2QY

Patents ADP number *(if you know it)* 07542301

If the applicant is a corporate body, give the country/state of its incorporation United Kingdom

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4. Title of the invention

"Exhaust Gas Cooler"

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Murgitroyd & Company

373 Scotland Street
GLASGOW
G5 8QA

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SEP 13 2001
TC 1700

Patents ADP number *(if you know it)* 1198013

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

Yes

Exhaust Gas Cooler

This invention relates to an exhaust gas cooler for reducing the temperature of exhaust gases from internal combustion engines. In particular the invention relates to an exhaust gas cooler in which a coolant is passed around passages through which the exhaust gas travels.

Figs. 1a to 1d show a known exhaust gas cooler. This prior art cooler comprises a circular tube 1 which has tapered ends 2 which serve as entry 3 and exit 4 orifices for exhaust gases. The orifices are provided with flange plates 10 for connection to exhaust pipes. The ends of the tube are sealed by circular tube plates 5 which define a coolant chamber inside the tube. Each tube plate 5 has a number of circular holes 6 arranged through it. The holes 6 in each tube plate 5 are connected by a number of small diameter tubes 7 which are sealed at one end to the first tube plate and at the other end to the second tube plate. Exhaust gases flow into the entry orifice 3, along the inside of the small diameter tubes 7 and out of the exit orifice 4. The exterior of the tube is provided with entry and exit nozzles 8, 9 which communicate with the coolant

chamber for the supply of coolant liquid.

The prior art exhaust gas coolers are bulky and do not fit easily within the frequently cramped engine layout. It is an object of the present invention to provide an exhaust gas cooler which is more compact in shape and yet provides flow characteristics comparable to prior art gas coolers.

According to a first aspect of the present invention there is provided an exhaust gas cooler comprising:

an external tube having first and second end walls within said tube, said external tube and end walls defining a coolant chamber between said end walls and first and second exhaust gas chambers outside said first and second end walls respectively,

coolant inlet and outlet means communicating with said coolant chamber,

a plurality of internal tubes extending from said first end wall to said second end wall and arranged such that the interior of each internal tube communicates with said first and second exhaust gas chambers, and

exhaust gas inlet and outlet means communicating with said first and second exhaust gas chambers respectively,

wherein the external tube has a cross-sectional shape which has a length in the major axis which is greater than its width in the minor axis perpendicular to the major axis.

Preferably the cross-sectional shape of the external tube is substantially oval, most preferably it comprises two semi-circles connected by common straight line tangents parallel to the major axis. Such a cross-sectional shape means that the exterior tube has

a planar face which simplifies the fitting of mounting brackets and placement within an engine compartment. An oval shape offers advantages over rectangular cross-sectional shapes, since the tube is less prone to cracking, and sharp re-entrant angles in the tube are avoided, reducing stress concentration.

Preferably the internal tubes are circular in cross-section. It has been found that circular tubes are less prone to clogging with particles carried by the exhaust gases than rectangular tubes, because they do not present internal corners in which particulate matter can collect.

Preferably the internal tubes are arranged in a hexagonal close packed arrangement, such that each internal tube is spaced by the same spacing from its closest neighbouring internal tubes. Preferably the spacing is less than 2 mm, most preferably less than 1 mm. Preferably the spacing is between 10% and 20% of the diameter of the tubes.

Preferably the exhaust gas cooler is made from stainless steel.

Preferably each of the exhaust gas inlet and outlet means comprises a flange plate adapted to connect to a corresponding flange plate on a connecting exhaust pipe and having an aperture therein to permit the through flow of exhaust gases. Preferably each of said first and second exhaust gas chambers is further defined by a tapering cylindrical member extending from said aperture to said external tube.

Preferably the coolant inlet and outlet means comprise tubular pipes adapted to be connected to a coolant

hose, most preferably extending substantially in the plane containing the longitudinal axis of the external tube and the major axis of the cross-section of the external tube. Preferably the coolant inlet means is located adjacent to one of the first and second end walls and the coolant outlet means is located adjacent to the other of the first and second end walls.

An embodiment of the invention will now be described, by way of example only, with reference to the accompanying figures, where:

Figs. 1a, 1b, and 1c are a side elevation, a partial sectional view on line A-A, and an end elevation of a prior art exhaust gas cooler;

Fig. 1d is an elevation on the flange plate of the exhaust gas cooler of Fig. 1a;

Fig. 2 is a side elevation of an exhaust gas cooler according to a first aspect of the invention;

Fig. 3 is an end elevation of the device of Fig. 2; and

Fig. 4 is a sectional view on line B-B of the device of Fig. 2.

Referring to Figs. 2 to 4 there is shown an exhaust gas cooler according to the invention. The cooler comprises an external cylindrical tube 20 whose cross-section comprises two semi-circular portions 21, 22 connected by two tangential portions 23, 24. At each end of the tube are fixed tapered cap portions 25 which are adapted to fit over the end of the tube and be fastened by suitable means such as welding. At the narrow end of the tapered cap portion 25 is a flange

plate 26 provided with two holes 27 for attachment to a corresponding flange plate (not shown) in order to secure the cooler to an exhaust pipe or line (not shown). The flange plates 26 also each contain a larger hole which serves as an entry 28 or exit 29 orifices for exhaust gases.

The ends of the tube 20 are sealed internally by two oval tube plates 30 whose shape corresponds to the internal profile of the tube 20. The volume bounded by the tube 20 and plates 30 forms a coolant chamber 31 inside the tube. Each tube plate 30 has 37 circular holes 32 arranged through it. The holes 32 are arranged in a close hexagonal packing (CHP) pattern as shown in Fig. 4. The holes 32 in each tube plate 30 are connected by 37 small diameter tubes 32 which are sealed at one end to the first tube plate and at the other end to the second tube plate.

It has been found that a CHP pattern maximises the flow efficiency, while the particular arrangement of Fig. 4, in which the three principal axes are arranged perpendicular to and at 30° to the major axis 40 of the tube 20 provides an optimum means of packing the interior tubes within the exterior tube.

Exhaust gases flow into the entry orifice 28, along the inside of the small diameter tubes 32 and out of the exit orifice 29. The tubes 32 have a diameter of between 5 and 8 mm, usually about 6.5 mm. The spacing between the tubes is about 1 mm or less, so the tube plate 30 does not present a significant obstruction to flow of the exhaust gases.

Arranged at a first end of the exterior tube is a cooling water inlet pipe 33 whose longitudinal axis is

in the same plane as the longitudinal axis 50 and the major axis 40 of the exterior cylinder 20. In this way the hose connections (not shown) will not extend outside the envelope defined by the width W of the exterior tube 20. Similarly at the second end of the exterior tube 20 is a cooling water outlet pipe 34 whose axis is in the same plane as that of the inlet pipe 33. The inlet and outlet pipes 33, 34 each communicate with the coolant chamber 31 for the supply of coolant liquid. As coolant passes from the inlet 33 to the outlet 34 and exhaust gases pass along the small diameter tubes 32, heat transfer takes place from the exhaust gas via the surfaces of the small diameter tubes 32 to the cooling water.

The oval shape of the apparatus enables the exhaust gas cooler of the invention to fit into much tighter spaces in the engine compartment than prior art coolers, while maintaining the benefits of closely packed tubes forming the cooling core. The layout of the tubes in the cooler according to the invention is novel while still maximising the efficiency of the gas and coolant flow. The cooler is highly resistant to corrosion due to its stainless steel construction, and very robust due to the absence of sharp corners on the exterior tube. The flow patterns achieved in testing have shown that the arrangement provides a high resistance to clogging from soot particles.

Although the invention shows a close packing arrangement with 37 tubes, giving the same flow area as prior art tubes, it is to be understood that other arrangements are possible. For example additional rows of tubes can be added, increasing the length L, without increasing the width W of the exterior tube 20.

These and other modifications and improvements can be incorporated without departing from the scope of the invention.

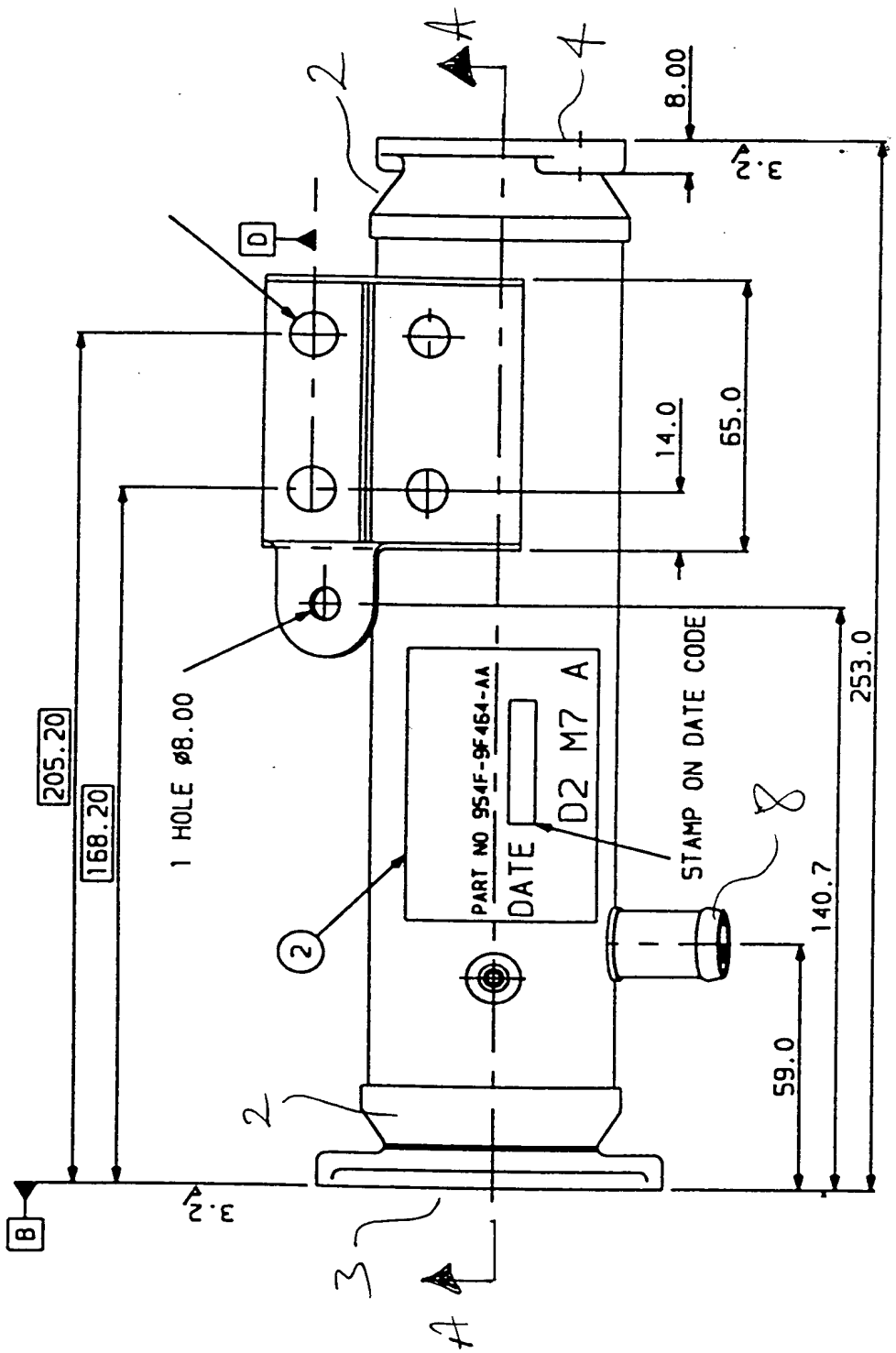
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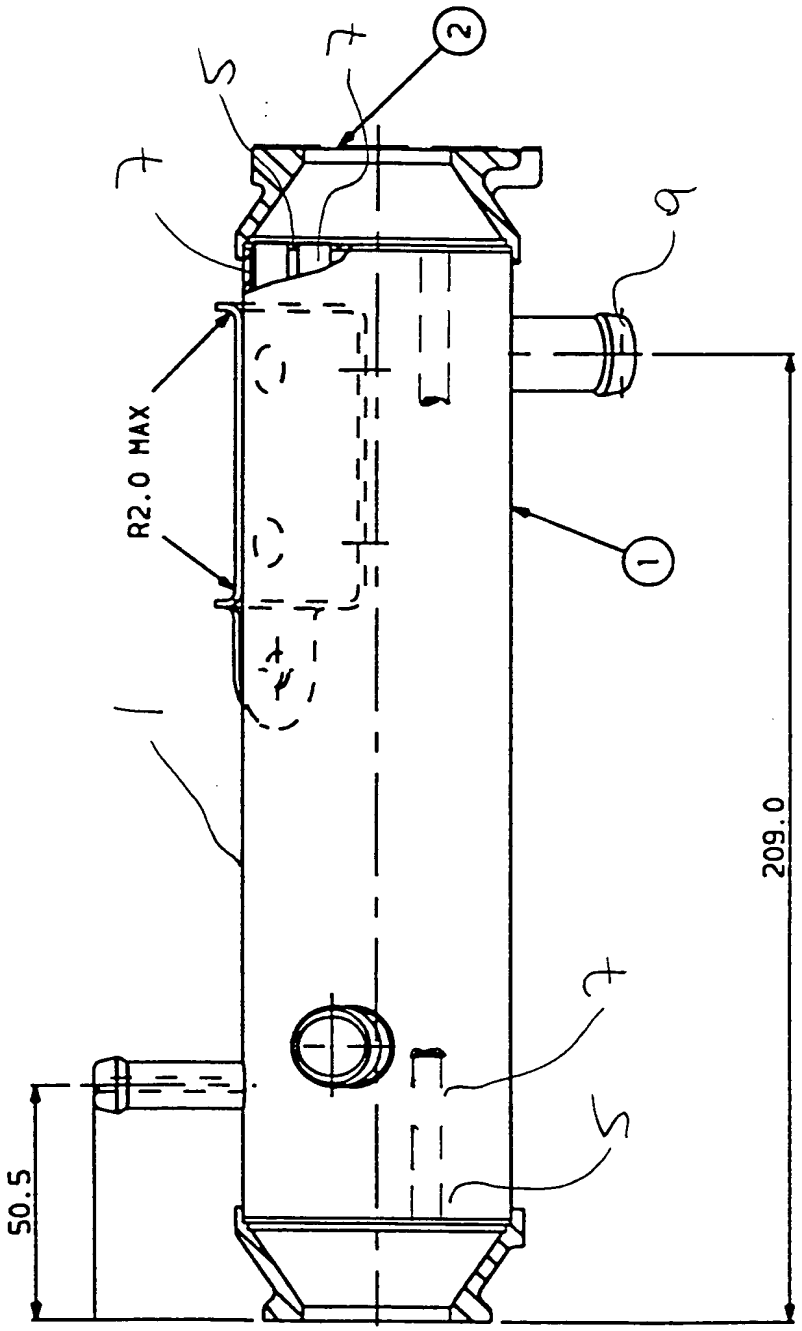
Fig. 1a

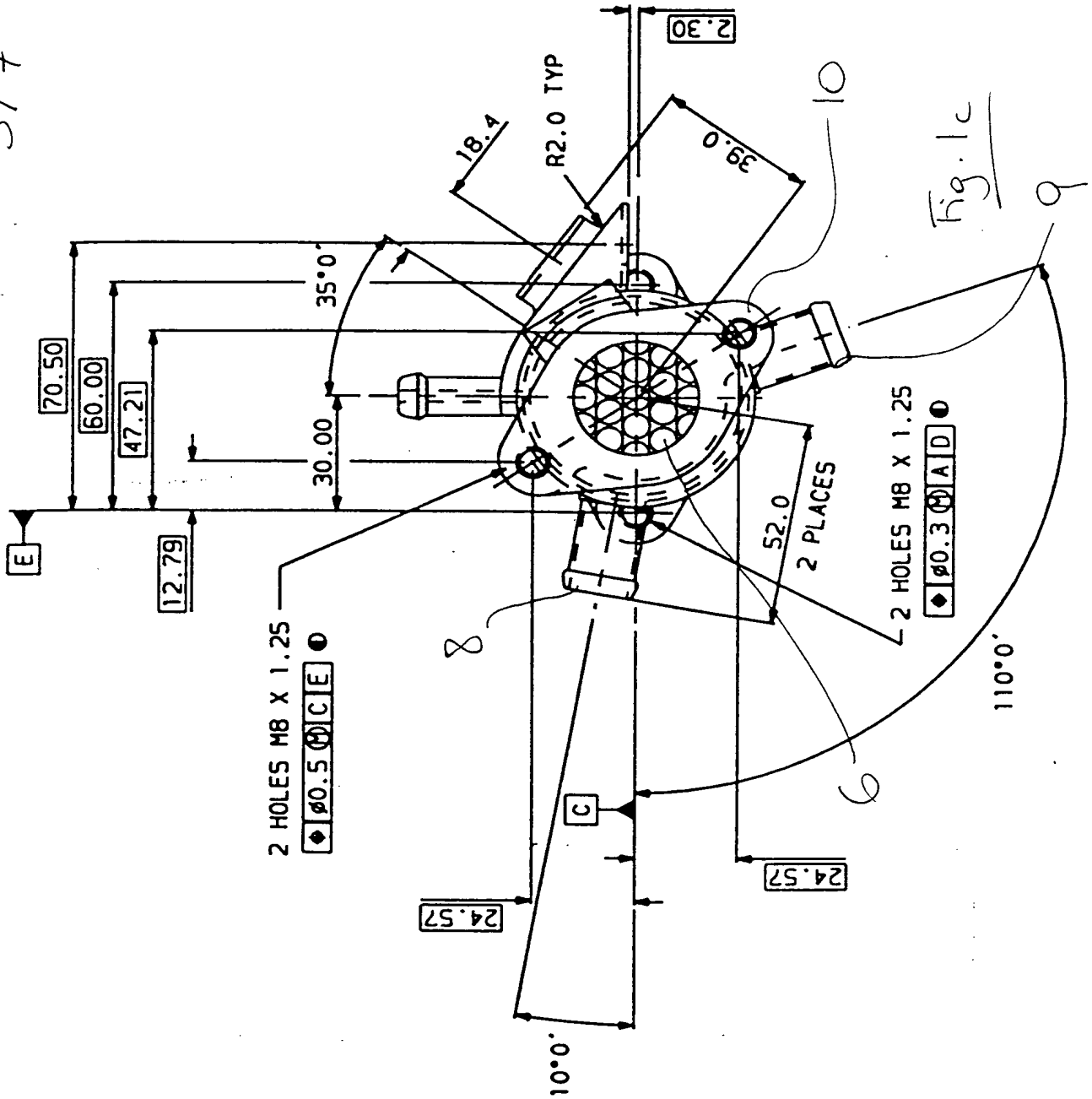
1/7



2/7

Fig. 1b

3/7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2 HOLES M8 X 1.25
⌖ ⌀0.3 Ⓜ A D
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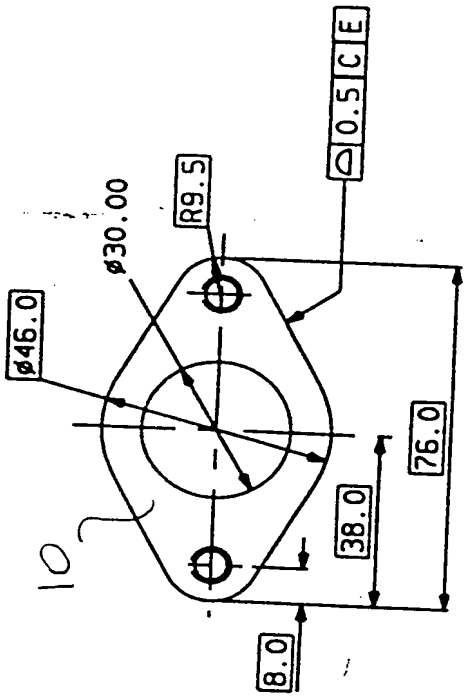
Fig. 1c



DETAIL OF FLANGE PROFILE
2 PLACES

Fig. 1d

4/7

5/7

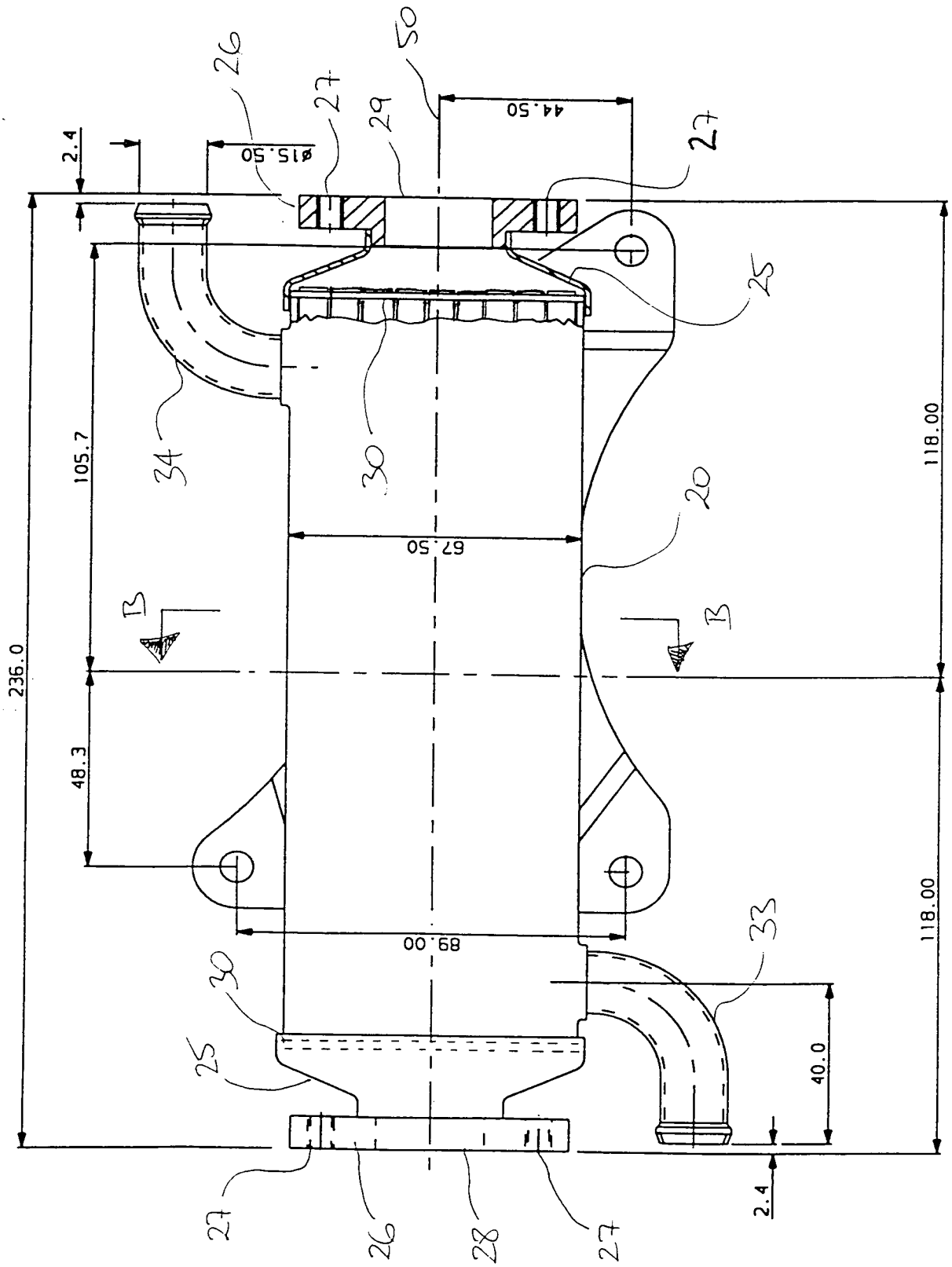

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Fig. 2

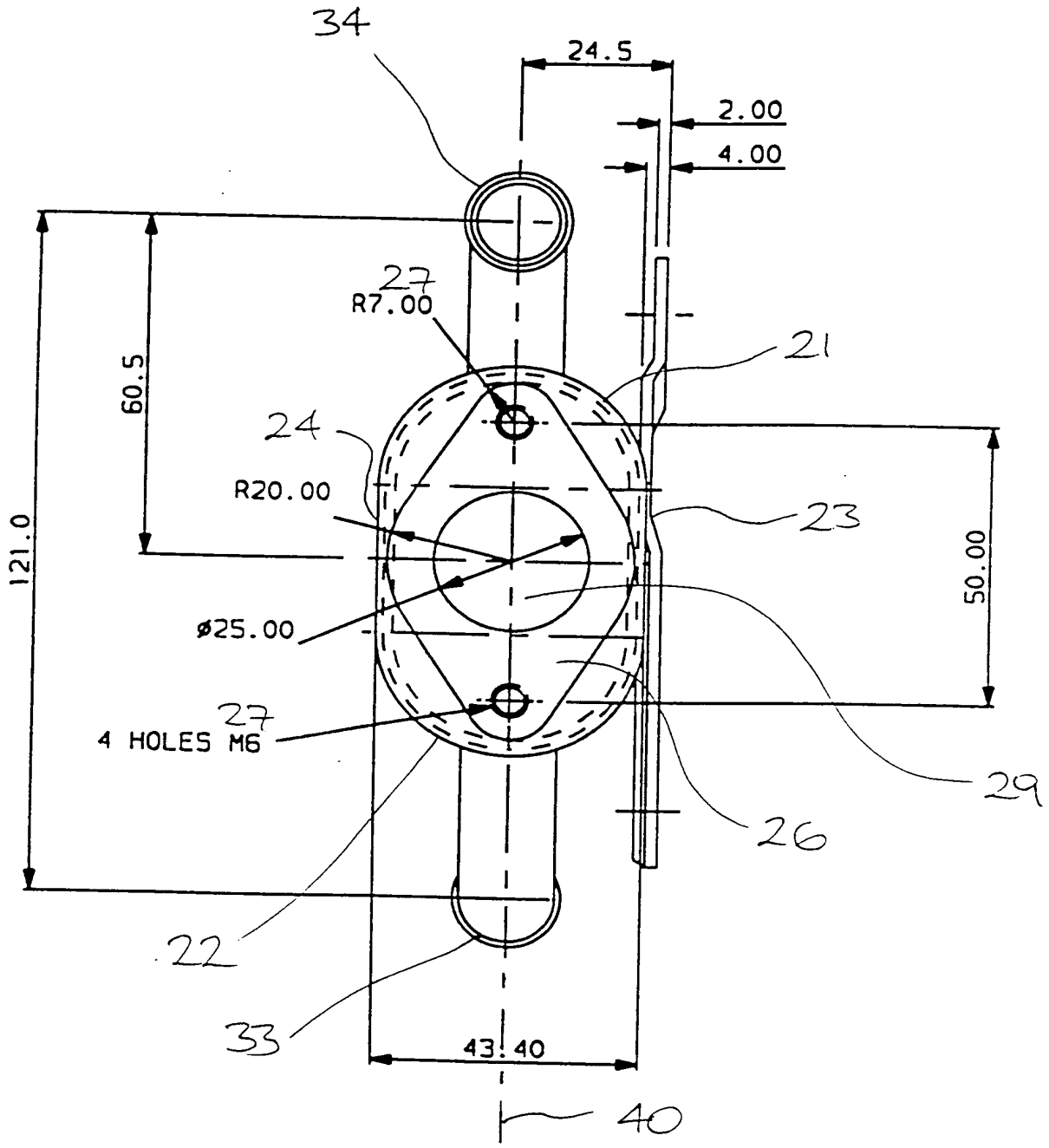
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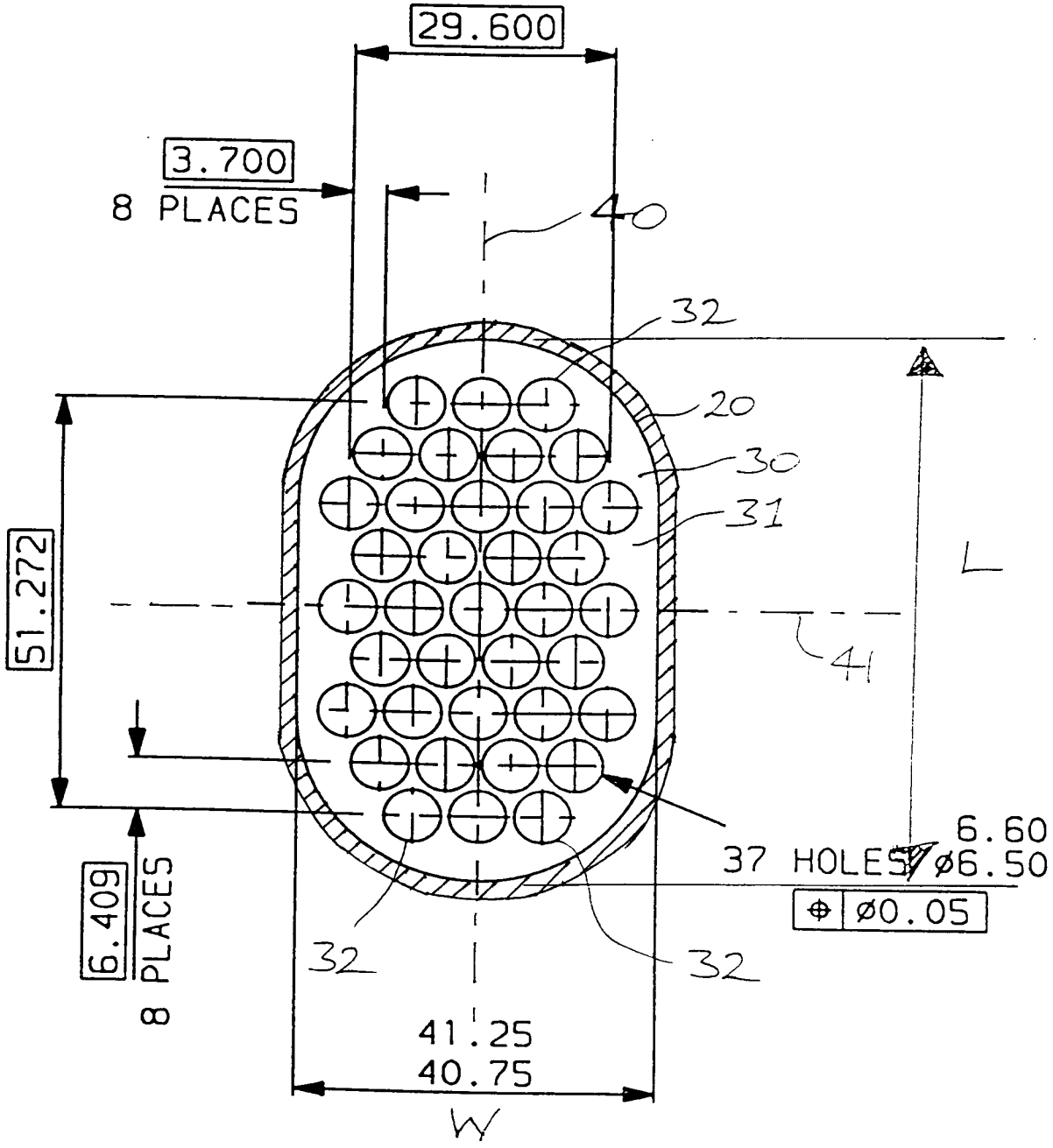
Fig. 3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40.75
W

Fig. 4

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